TRMM MSR
New Mission Director
Receiving Review

December 6, 2000

Introduction

- Operations Status - Engineering Staff
  - Introduction - Andy Calloway
  - Flight Ops Summary - Lou Kurzmiller
  - Electrical & Thermal - Andy Calloway
  - ACS & FDS / C&DH - Mark Fioravanti
  - RCS & RF / Comm - Rob Bote
  - Power & Deployables - Justin Knavel
  - LIS - Justin Knavel
  - CERES & VIRS - Mark Fioravanti
  - TMI - David Corley
  - PR & FSS Interference Background - Andy Calloway
  - Ground System - Dan Palya
  - Upcoming Activities - Andy Calloway

Introduction

- Spacecraft
  - Launched with ETS-VII on November 27 1997 (97-331) at 21:27:00z on an H-II from Tanegashima, Japan - 3 Year Anniversary last week
  - Earth pointing, 3-Axis stabilized, at 35° inclined frozen orbit
  - +Y side of the spacecraft kept out of sun via 180° yaw turns
  - Low altitude requires frequent orbit adjust maneuvers (Delta-Vs)
  - 5 Instruments: PR, TMI, VIRS, CERES, LIS
    - » CERES instrument has DAP failure and +15v converter failure
  - All subsystems healthy;
    - » -Y side SADA hotter than predicted at high beta angles
      - lubricant evaporation a legitimate concern
    - » Operating with Clock Card-B/FS-B after seeing A-side glitches during final mission sim
    - » Fuel consumption is primary EOL trigger point at this time

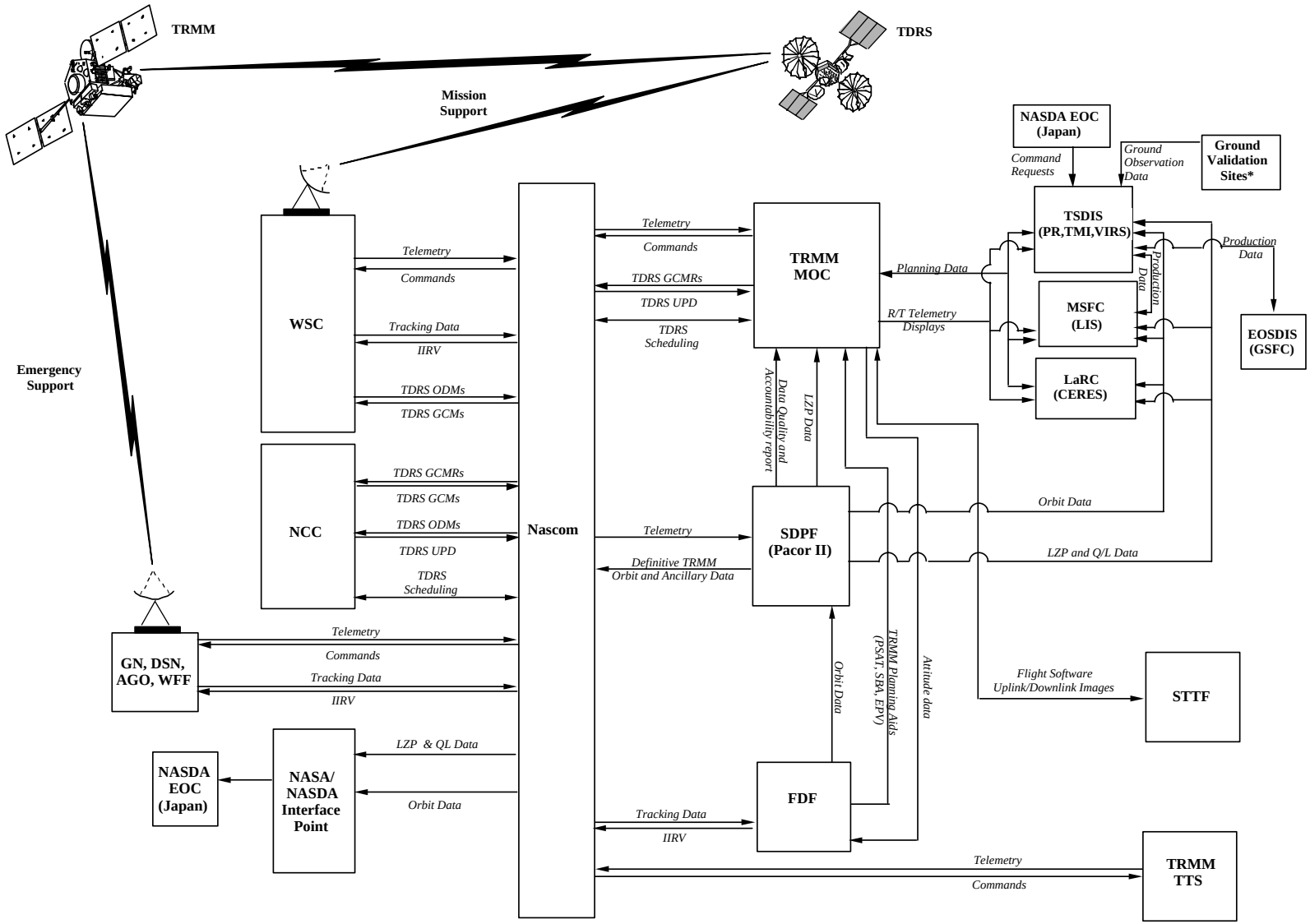
Introduction

- Operations
  - 2 person 12-hour shifts; around-the-clock coverage
  - 15-18 real-time SN TDRS events per day, nominally 20 minutes each
    - » Nominal events are I-Chnl: 32k Q-Chnl: 2048k; Coherent; Xpdr 1
    - » 1 Non-coherent transponder trending pass each day
    - » 3 1/4k non-coho omni events per week for transponder 2 trending
  - ATS Load with AOS/LOS commands and instrument requests uplinked daily
  - TRMM EPV uplinked daily (except Delta-V days); propagates @20:00
  - TDRS EPVs uplinked monthly

Introduction

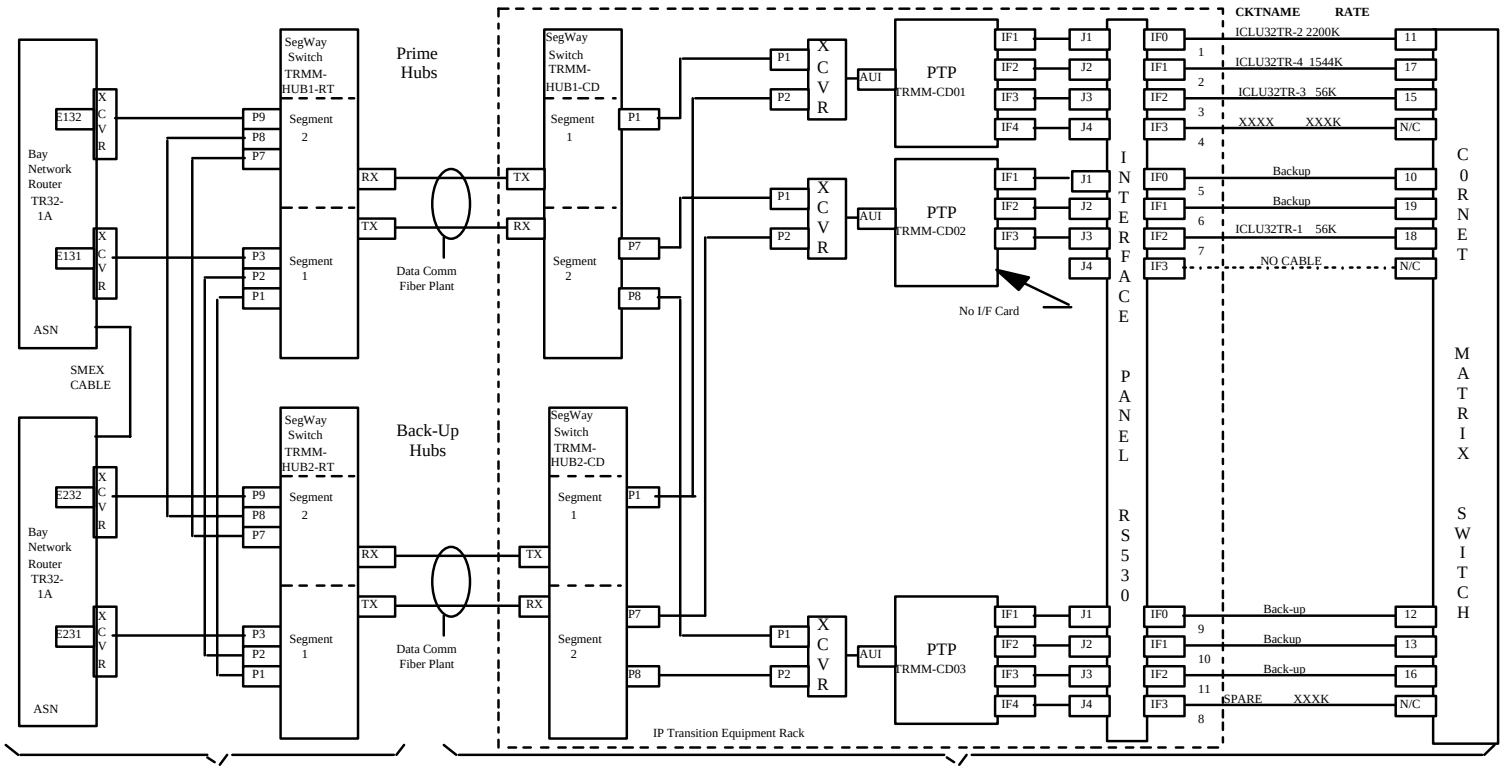
- Operations continued
  - Hourly and daily statistics for trending mnemonics kept since launch
  - Regular telemetry of trending mnemonics kept on-line for 3 months
  - All engineering data stored on CDs made by DDF since launch
    - » Used frequently for reviewing past anomalies and trending
    - » Receive ~73 CDs per year
  - Power Analysis reports generated daily
  - Hourly statistics plots generated monthly and reviewed by engineers
    - » Duration of Mission plots also generated several times a year
  - New ODB generated periodically as new derived mnemonics are created and as limit definitions change

System Overview



Ground System

EC No: 541-1281
EC Title: Nascom IP Transition: TRMM



System Block Diagram, TRMM

10/12/98

Flight Operations Summary

- Supported 549 SN events in November
  - 1 Yaw Maneuver
  - 12 Delta-V Maneuvers
- 8 Event Rpts & 1 Generic Late Acq Rpt generated
  - ER #214 & ER #221: FDF; TRMM & TDE EPV Continuity
  - ER #215: NISN H/W; Router hang-up at IPNOC
  - ER #216: MOC H/W; FEP's 1 & 3 unable to boot
  - ER #217: SN; NLIC card at WSGT not enabled
  - ER #218: SN; TDE emergency timeout
  - ER #219: SN; STGT S/W delivery, lost 3 events
  - ER #220: NISN H/W; Segway Lanart Router hangup

Flight Operations Summary

- Notable Events
  - Weathered router upgrades & UPS maintenance
  - Leonids meteor shower

Flight Ops Summary

SPECIAL SPACECRAFT EVENTS AND ACTIVITIES FOR TRMM 2000													
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	**TOTALS**
2	6	8	10	13	9	7	9	8	8	12	12		102
2a	1	1	2	1	1	1	2	1	1	2	1		14
2b	0	0	0	0	0	0	0	0	0	0	0		0
2c	0	0	0	0	0	0	0	0	0	0	0		0
3	2	1	0	1	2	2	2	2	1	1	1		15
3a	5	1	3	7	4	4	2	4	6	9	6		51
3b	3	1	2	4	4	3	3	6	3	3	5		37
3c	0	3	2	2	0	0	2	0	2	2	2		15
3d	1	0	1	0	0	0	0	0	1	1	0		4
3e	0	0	0	0	0	0	0	0	44	0	0		44
3f	6	1	3	3	5	2	2	4	3	1	1		31
4	3	3	0	3	3	5	0	2	1	1	3		24
4a	2	2	2	2	2	2	2	2	2	2	4		24
4b	1	2	2	1	2	1	1	2	1	2	1		16
4c	0	7	21	23	10	19	12	3	1	0	0		96
4d	11	0	4	1	4	2	4	1	2	4	2		35
4e	0	0	0	0	0	0	0	0	0	0	0		0
5	26	6	4	5	16	11	9	5	6	16	5		109
5a	0	0	4	0	1	4	2	0	0	0	0		11
5b	3	3	2	3	0	0	2	1	2	4	1		21
5c	0	0	0	0	0	0	0	0	0	0	23		23
8	0	0	0	0	0	0	0	0	0	0	0		0
8a	0	0	0	0	0	0	0	0	0	0	0		0
TOT:	70	39	62	69	63	63	54	41	84	60	67	0	672

LEGEND

CSOC CATEGORIES		**TRMM SUB-CATEGORIES AND EXAMPLES**
1	Targets of Opportunity	N/A
2	S/C Maneuvers	DeltaVs **(2)** , 180° Yaw Maneuvers **(2a)** , 90° Yaws **(2b)** , Deep Space Cals **(2c)**
3	Unplanned Events	Blind Acqs **(3)** , Patch Loads **(3a)** , Manual DS Ops - Blind Acqs, MI, H/W Problems **(3b)** , EPV Fail Ops **(3c)** , VIRS Reset Recoveries **(3d)** , Anomaly Recoveries **(3e)** , Generic Late Acqs - GCMRs and Manual DS Ops **(3f)**
4	Customer Requests	PR **(4)** , VIRS **(4a)** , LIS **(4b)** , CERES **(4c)** , FSW **(4d)** , AETD **(4e)**
5	Celestial Phenomena	VIRS Heater Ops **(5)** , Power Ops - Autospru, TSMs, C/D **(5a)** , UTCF / FS Ops **(5b)** , Leonids Ops **(5c)**
6	Pre-Launch Testing	N/A
7	L&IOC Operations	N/A
8	EOL Operations	Delta-H Firings **(8)** , Reentry Maneuvers **(8a)**

Thermal / Electrical Subsystems

- Thermal and Electrical subsystems remain nominal with no open issues
- FOT will assist AETD as needed for End Of Life Thermal Analysis
  - Will Kim Brown be working this issue?
    - » What is lowest attainable perigee which still meets thermal survivability constraints
    - » What are the thermal constraints, if any, of long duration burns with respect to non-thruster spacecraft components
- No relay or other Electrical issues at this time
  - Monitor any affects of CERES turn-on with respect to current inrush

ACS Subsystem

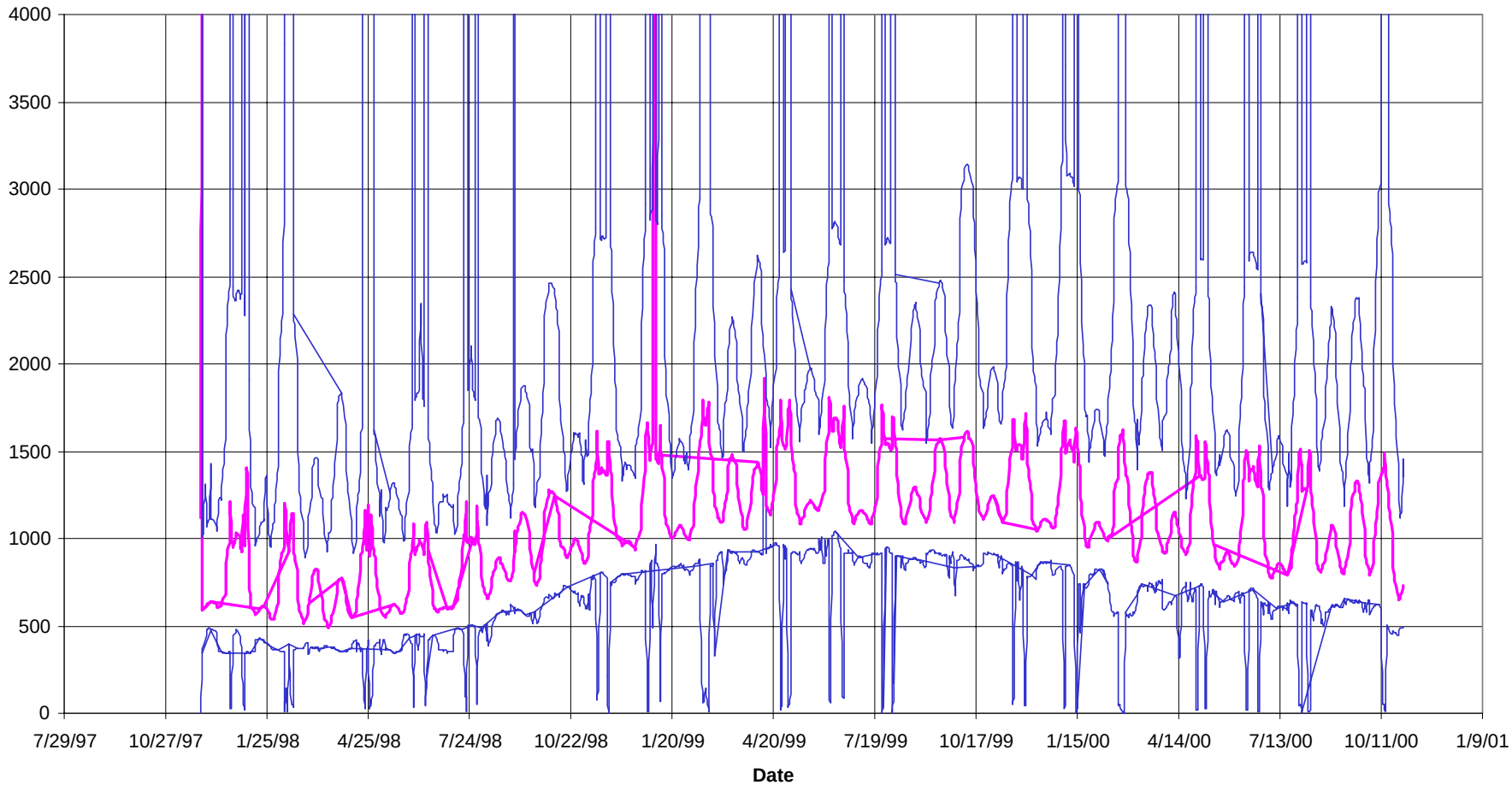
- 2 Sun Acq occurrences occurred since launch - limits set too tight; no actual problems with spacecraft
- Solar Array jitter (AR #74)
  - ACS software patch (CCR #052)
  - Changes made to Solar Array Sun tracking code: Computations of the Sun position in the SA frame will use nominal Sun position based on the nominal attitude
- Yaw updates show seasonal changes
- TDRS EPVs still sometimes fail in position and velocity following TDRS maneuvers (AR #60 - CCR #035)
- TRMM EPVs are failing in the position following Delta V maneuvers.

ACS Subsystem

- ESA fogging
  - Focused in Quadrant 1
  - Action threshold is ~2500 counts (sustained mean)
    - » Look into table bias changes
    - » Start thinking about Contingency Mode (checked out during L&IOC)
  - Manufacturer (Barnes) is not concerned with current performance

ACS Subsystem

ESA Space Counts Quad 1



ACS Subsystem

- Open CCRs (In order of Priority);
  - CCR #069: New table 85 to match new TDRS-8 continuity limits for other TDRS, and another table 85 to widen the limits after an update failure.
  - CCR #070: New version of Table 61 to incrementally pitch the S/C while in SunAcq.
  - CCR #005: Correction for Magnetic Field Epoch, will be required for EOL if apogee is greater than 400 km.
  - CCR #065: Update ACS system tables in preperation for EOL activities.
    - » Table #73 (Thruster Parameters)
    - » Table #90 (Mode Configuration Data for Contingency)
  - CCR #053: ACS FS/W bug

FDS/C&DH Subsystems

- UTCF Status;
  - UTCF allowed to drift full range of requirement (~900 μs)
  - One Adjustment was performed on 00-332 (Monday, November 27th, 2000)
  - Current UTCF value is 31535996.834676 sec
- FS Status;
  - Exhibits strong negative drift, loses ~0.1 μs/hr/day
  - Current FS value is x'7ae'

FDS/C&DH Subsystems

- Open CCRs;
  - CCR #034: Writing from RAM to EEPROM for new TSM table #21 and RTSs # 2, 3, 13, 14, and 15. Completed, only need final documentation.
  - CCR #047: Will work with FSW on no-clock software patch activities
  - CCR #048: New on-board DS filter table to record ACE 8-Hz data
  - CCR #071: Build a new DS quota table (73) to reallocate CERES science memory to other instruments, contingent on powering CERES off permanently.

RCS Subsystem

- No Open RCS Anomaly or Event Reports
- Upcoming Events
  - Begin review of, and training in, Delta-H procedures and scripts for EOL
  - Review operations in preparation for long duration Delta-V/H maneuvers

RCS Subsystem

- Delta-V Operations
  - Maneuvers scheduled as-needed depending on solar activity
  - Currently averaging 1 maneuver every 3 days
  - Expected to decrease frequency as solar maximum subsides
  - Performed 12 successful Delta-V maneuvers (#243 - #254) in November

RCS Subsystem

- Fuel Budget Analysis:
  - Spreadsheet developed by FOT with RCS Code 713 engineers
    - » outputs expected life by relating average daily fuel consumption with predicted solar flux levels - updated monthly
      - Original 68 kg reserve yields April 2004
      - Proposed 200 kg reserve yields September 2003
  - Currently 488 kg fuel remaining

RCS Subsystem

- End of Life Status
  - Pre-Launch EOL Plan
    - » 5 to 8 week orbit decay phase to 200 km, then controlled reentry using 58 kg of fuel
    - » End science mission when 68 kg fuel remaining
  - Proposed EOL Plan
    - » Controlled reentry from mission altitude using 121 kg of fuel
    - » End science mission when 200 kg fuel remaining
  - No thermal constraints for EOL

RCS Subsystem

- Performance Issues
  - Thruster misalignments minimal and well understood
    - » ISP burns: -Pitch (#6) off-modulates 30-35% (0% roll pulsing)
    - » LBS burns: +Pitch (#2) off-modulates 15-20%

      -Yaw (#1) off-modulates 5-8% (0% roll pulsing)
  - LBS burns sometimes have 1-2 second plateau in pitch momentum 7 seconds into first burn
    - » no operational impact

RF Subsystem

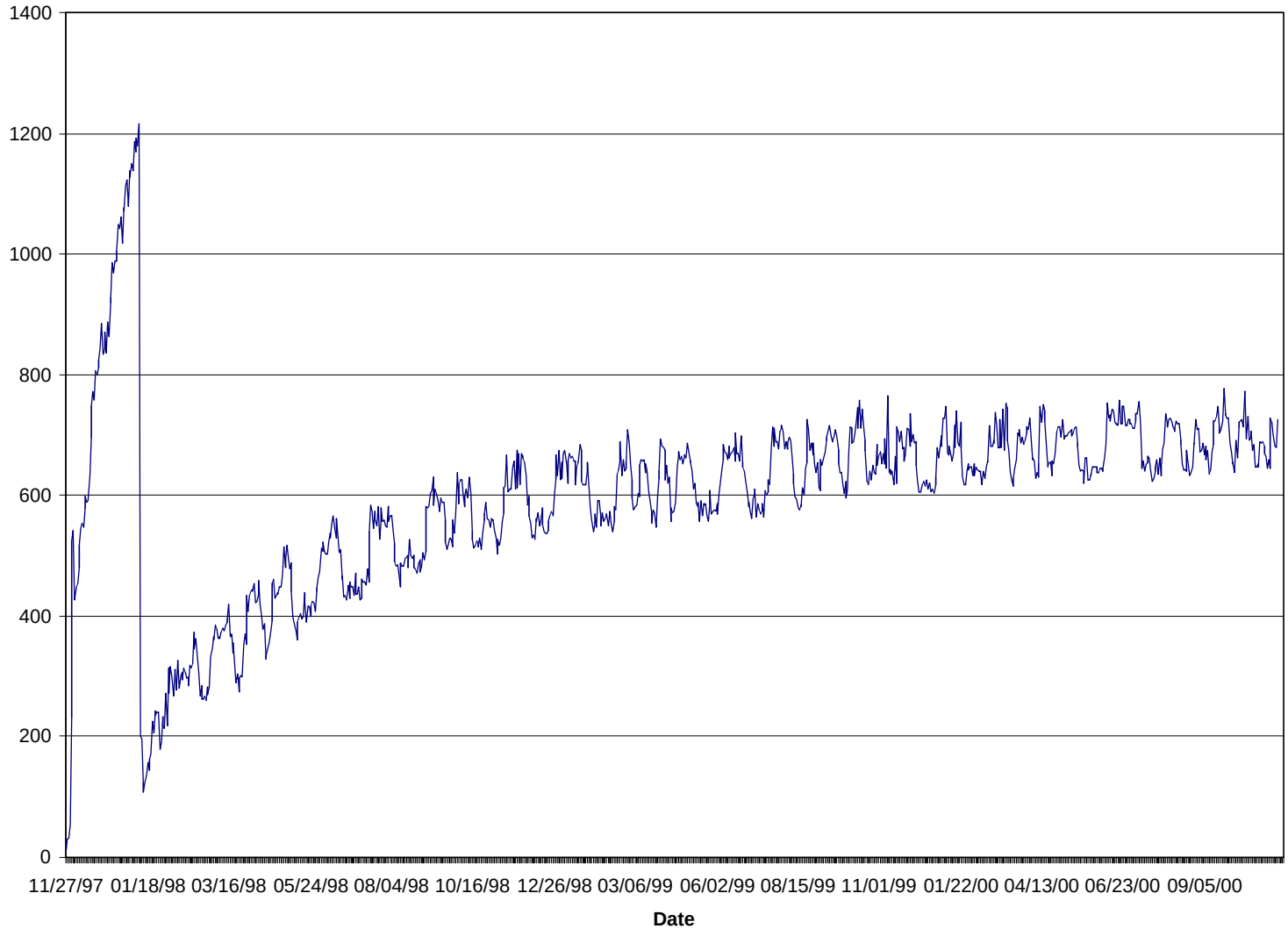
- Generic Late Acquisitions
  - Common event for SN users
  - No indication of subsystem problem
  - Mostly seen on TDRS West
  - 1 Generic Late Acquisition (#74) in November
- Training/Risk reduction
  - Performing 1/1 k events once a week
    - » Safe Mode proficiency training
    - » on hold until table update fixes event dump bottleneck
- Upcoming Events
  - Offset of transponder frequencies likely within 3 months

RF Subsystem

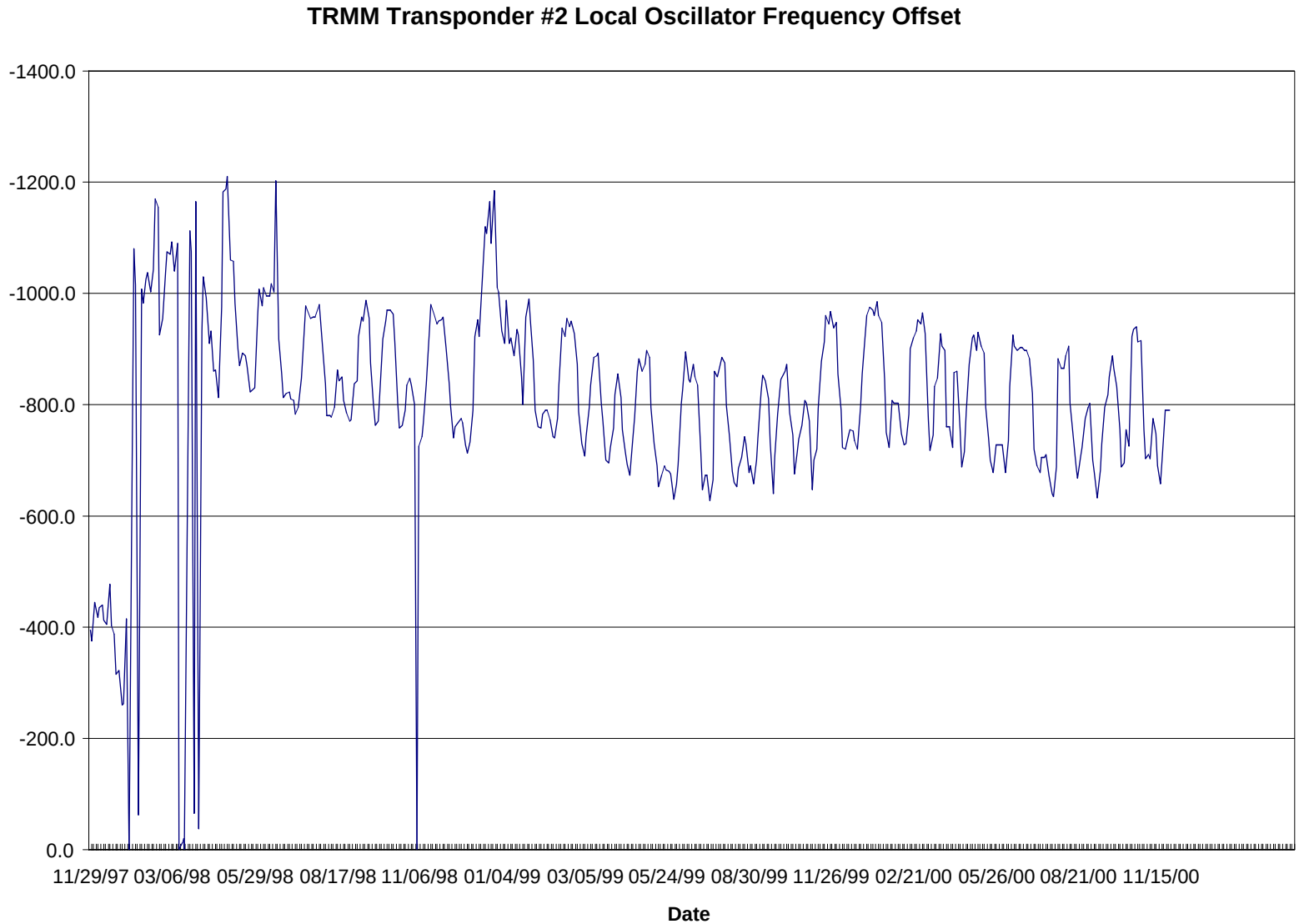
- Local Oscillator Frequency
  - Frequency varies with temperature
  - Frequency drifts over time
- Frequencies settled at +/- 700 Hz
  - XP1 trended once a day, XP2 three times a week
- November Frequency offsets
  - Transponder #1 = +684.160 Hz (average)
  - Transponder #2 = -742.582 Hz (average)

RF Subsystem

TRMM Transponder #1 Local Oscillator Frequency Offset



RF Subsystem



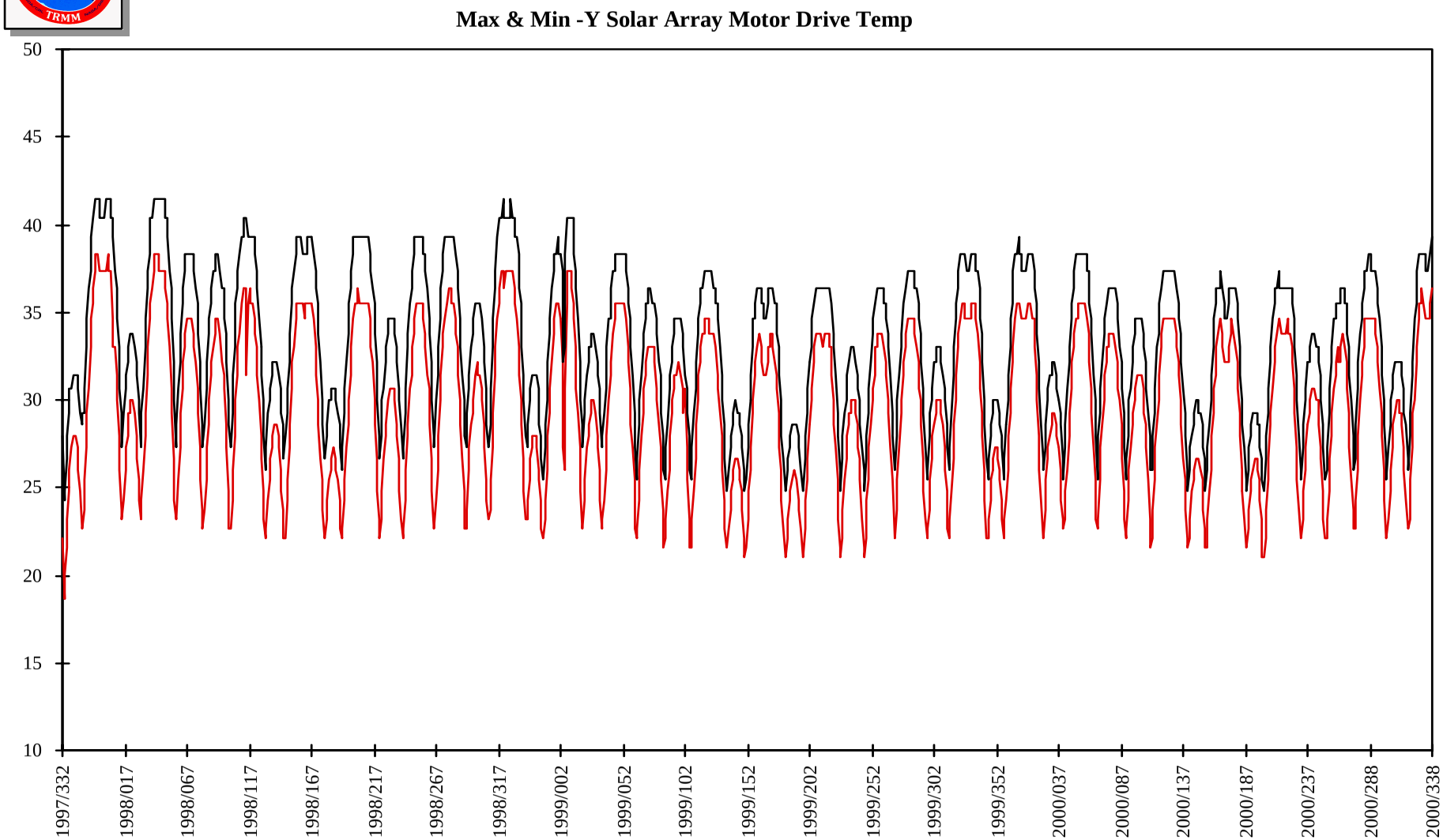
Power Subsystem

- 00-307(November 2nd) - New RTS 21 and TSM Table 21 were uplinked.
  - All Power RTSs enabled.
  - Power TSMs enabled, except for TSM 37 - 40 (Differential Voltage Average).
  - TSM 37 - 40 will only have Event Messages at 3 Thresholds. Testing is on-going.
- No change in PSIB A or B telemetry.
- No other open issues.

Deployables Subsystem

- -Y solar array drive temperature
  - YH temperature: 42° C; Life test temperature: 37° C
    - » Came within 0.5° C of yellow high temperature
  - A 10° C increase in temperature is 100 times more likely to evaporate the lubricant and may potentially cause undetected levels of metal particles. Bearing temperature cannot be measured directly.
  - Reaches maximum temperature at high beta angle.
  - 98-349 - Solar Array software stops implemented. The Solar Array tracks between +/- 50° (originally +/- 130°).
  - ACS Patch also reduces noise in sensed velocity
- HGA antenna
  - No loss of RF lock during Delta-V and Yaw maneuvers
- Solar array drives and HGA continue to operate nominally
- No open issues other than to concentrate on array behavior

Deployables Subsystem



LIS Instrument

- Routine MSFC real-time command requests are performed approximately once per month to reduce accumulated packet sequence errors
- One performed on November 13th (00-318)
- Two related anomaly reports generated since launch: AR 76/78
  - Automatic Heater controller autonomously switched to secondary heater and then switched both off even though temps were nominal
  - MSFC distributed official LIS Thermal Switching Anomaly report in 10/99; Authorization given to permanently disable the controller
- No open issues

CERES Instrument

- Power On will be attempted on or about 00-348 (December 14th, 2000)
- Open Issues
  - Data Acquisition Processor (DAP) Telemetry Drop Out and Possible Failure (Anomaly #81)
- Issues on Hiatus
  - Continuous Biaxial operations
  - DR on MP ground system to incorporate new CERES requirements

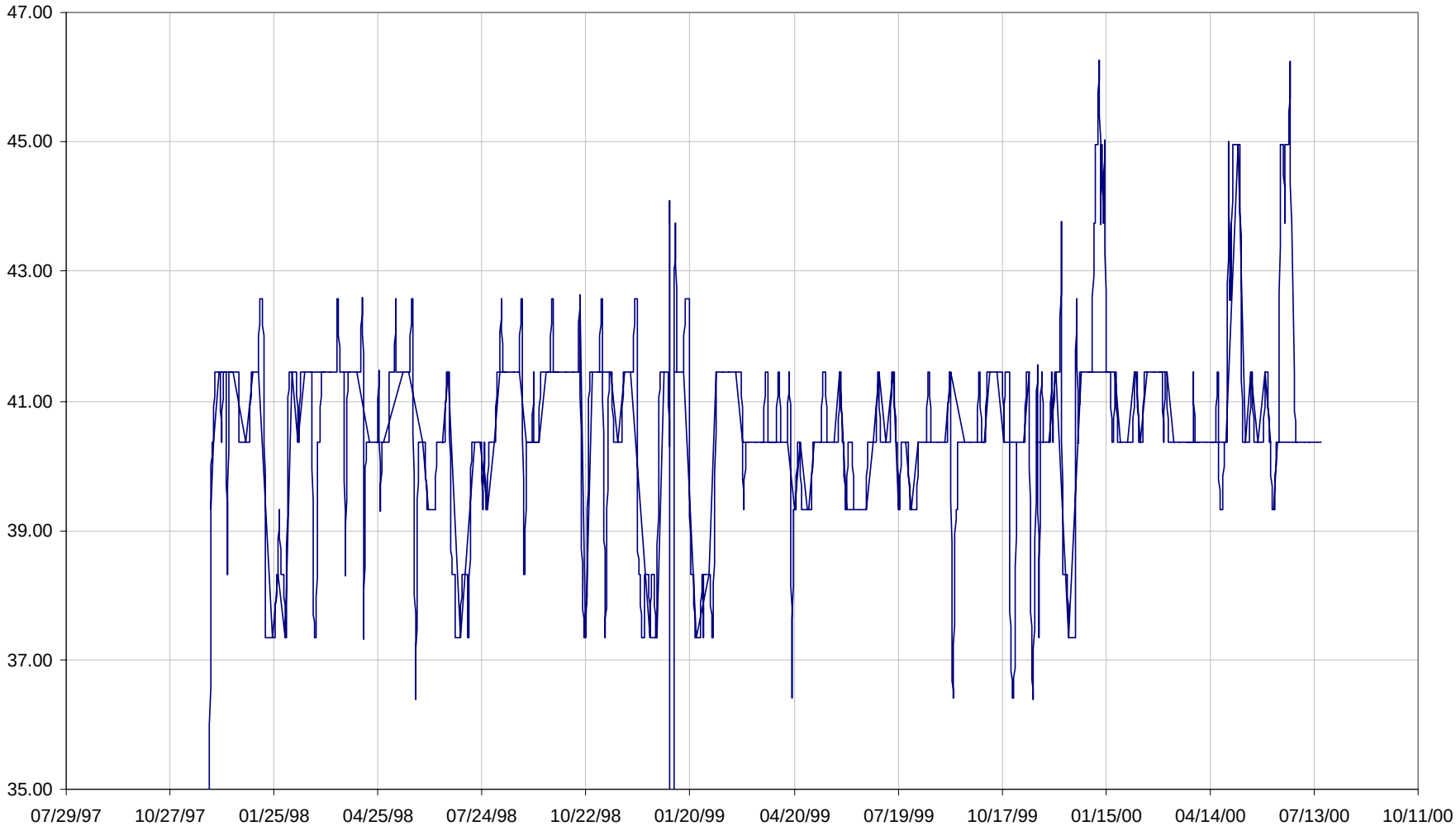
VIRS Instrument

- Powered off for Leonid Activities on 00-317
- 2 Solar Calibrations were performed on 00-317 (Tuesday, November 12th, 2000)
  - Since the Loadshed & PSIB Anomaly the Solar Calibration door has not been opening fully during the Solar Calibrations (AR#84)
  - Door is now reaching the 90% open position, originally only 70% open.
  - Bump Open command may resolve the problem.
- No VIRS Resets this month.
  - Usually performs a reset every other month, to date there have been 15 resets.
  - An LOP and a recovery procedure have been developed.
- VIRS Blackbody temperature must be maintained between 8^{o} and 16^{o} C.
  - Temperatures between 1^{o} – 4^{o} C corrupt science data from 1 pixel.
  - Temperatures are maintained with 8.5 and 15 Watt heaters.

VIRS Instrument

- VIRS Blackbody temperature must be maintained between 8^{o} and 16^{o} C.
  - Temperatures between 1^{o} – 4^{o} C corrupt science data from 1 pixel.
  - Temperatures are maintained with 8.5 and 15 Watt heaters.
- VIRS Power supply temperature spikes
  - Temperature is nominally about 42^{o} C
  - When both Heaters are on the temperature spikes to about 45^{o} C (yellow high), happens a high beta angles (above +/- 45^{o})

VIRS Instrument



TMI Instrument

- Instrument was last powered OFF during Lenoids on 00-317
- No open issues with the instrument currently.
- Deep Space Calibration (Inertially Fixed Mode) done on 98-245 to determine source of interference seen in the science data
  - Determined that PR was not the source
  - Interference is currently being masked out in ground processing
  - Currently no other calibrations are planned because of risk to VIRS (thermal short)

PR Instrument

Overview

- PR Instrument Healthy
- External calibrations performed about twice a month
  - 1 on 11/3 and 2 on 11/4
- PR Logampcheck command request performed on 11/20
- PR Open Issues
  - Frequency Agreement Renewal
    - » New interference reported by NASDA in November: Eastern Atlantic, Bahamas, and Sao Paolo, Brazil

TRMM PR Interference Background

- PR Frequency: 13.799 GHz
- International Telecommunication Union (ITU) Radio Regulations provides the rules we are bound by (a UN Treaty Organization)
- Primary Fixed Satellite Service (FSS) allocation added for 13.75 - 14.0 GHz band at the 1992 World Radio Conference
  - Footnote added to gain protection for non-Geostationary space research and earth exploration satellites (TRMM) until 1 Jan 2000 (S5.503A)
  - This footnote also recommends FSS operators who are coming on-line from 1/1/2000 - 1/1/2001 to utilize consultation process outlined in ITU-R Recommendation SA.1071 (sent to you as an e-mail attachment): *THIS IS OUR CURRENT ARRANGEMENT FOR 3 MORE WEEKS*
    - » S5.503A: Until 1 Jan 2000, stations in the fixed-satellite service shall not cause harmful interference to non-geostationary space stations in the space research and Earth exploration-satellite services. After that date, these non-geostationary space stations will operate on a secondary basis in relation to the fixed-satellite service. Additionally, when planning earth stations in the fixed-satellite service to be brought into service between 1 Jan 2000 and 1 Jan 2001, in oder to accommodate the needs of spaceborne precipitation radars operating in the band 13.793 - 13.805 GHz, advantage should be taken of the consultation process and the information given in Recommendation ITU-R SA.1071.

TRMM PR Interference Background

- Doug Boyd (Local CSC: dboyd@csc.com) and Pete Lowry of the Spectrum Management Office (NASA: plowry@grc.nasa.gov) are the points of contact
  - They actually contact FSS administrators directly and maintain a database of interference, operating FSS sites, new FSS sites, etc.
  - Currently only about 20 FSS filings in this band (out of 500+), each with only a handful of earth stations
  - Doug/Pete have provided comments to every FSS administrator that has filed with the ITU in this band informing them of the TRMM operations which need to be protected
- As of January 1, 2001 there is no longer any requirement or obligation for FSS uplinks to protect TRMM operations!!
- Joe Deskevitch (jdeskevi@pop500.gsfc.nasa.gov) working with Doug/Pete and C. Wendy at HQ (cwende@hq.nasa.gov) to try and extend the agreement outlined in S5.503A until TRMM EOL

TRMM PR Interference Background

- CSC has written a proposal, reviewed by the Spectrum Office at GRC and R. Lawrence here at GSFC (see attached).
  - No word yet as to when this proposal will be approved
- PR currently stops radiating when over small zone of Australia (PR Internal Calibration is performed)
  - Mission Planner uses FDF Predicted Satellite Acquisition Tables (PSATs) which contain fly-over times based on zone parameters
- Operationally, this arrangement could be extended to other FSS sites as part of an agreement if accurate zone Lat/Long parameters are provided to FDF.

Ground System

- NISN Router Upgrade. Two events impacted.
  - Router had to be reset. All data was recovered.
- FEP-1&3 Boot failure
  - New Static Routes were established in MOC s/w.
- NLIC Card not enabled. S/W delivery. 3:46 sec VR6 (Virs) data loss.
- TDRS ETO. Multiple User Impact. No data loss.
- NCC deleted 3 events due to adverse effect of new STGT s/w delivery.
  - New events scheduled and a patch load built.
- UPS-6/5 outage successfully implemented.
  - Events were supported on String -2 (UPS-2)
  - Dropped lock caused by NISN's Lanart Segway router.

Ground System

- Completed all PTP HD updates with Linux s/w

  - will begin transition from OS2 to Linux over next 30 days

Upcoming Activities

- 0-2 Months
  - Extended Mission Operations Begin (1/2000)
  - Ensure FOT training remains top priority
  - Complete PSIB-Anomaly investigation and activities
  - Power the CERES instrument back on
  - New FDF Product deliveries which will incorporate new TDRS-8 data
  - Completion the Backup Control Center failover implementation
  - Continue to close open CCRs, MOCRs, ERs, ARs, and MSR Action Items

Upcoming Activities

- 2-3 Months
  - System Software Release 8.2 Delivery; Begin testing and using the new TDRS-8
  - Begin to test, validate the new PACOR-A system
  - Commence DSN/GN FOT training
- 3-12 Months
  - Transponder Offset Activities possible
  - End Of Life Planning, Testing, and Simulations